

Division of Marketing
Agricultural Development and Diversification (ADD) Program
1991 Grant Final Report

Grant Number 06047

Grant Title Evaluation of Agronomic Adaptability, Economic Productivity &
Industrial Utilization Potential of Kenaf in Wisconsin (Phase I)

Amount Awarded \$14,800.00

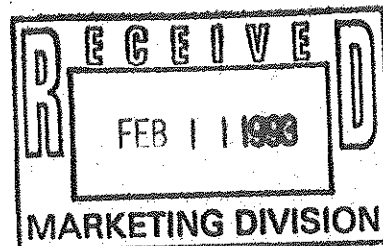
Name Pat LeMahieu

Organization Agrecol
Sun Prairie

E-Mail

WEB

Department Contact: DATCP - Marketing - ADD Grants
PO Box 8911 Madison, WI 53708-8911
Tel: (608)224-5136
<http://datep.state.wi.us>



To: Monique Lomax
From: Pamela A. Porter *PA Porter*
Re: Third Round Annual Report (June 1, 1991 through January 1, 1992)

Evaluation of the Agronomic Adaptability, Economic Productivity and Industrial Utilization Potential of Kenaf in Wisconsin (Part one)

In 1991 kenaf seed was obtained from Chuck Webber of the International Kenaf Association for the summer plot work. The field experiment was conducted in 6 locations across Wisconsin including the site at AGRECOL CORPORATION in Madison, WI. Sites included Hancock, Marshfield, Arlington, Spooner and Madison (2). Experimental design and data analysis at these five sites was conducted under the direction of Dr. Ed Oplinger at the UW- Madison. Experimental design and data analysis at AGRECOL CORPORATION was conducted by Patrick J. LeMahieu. Results of the 1990 and 1991 field seasons are enclosed.

In 1990 at Madison, WI, growing conditions for kenaf were excellent and the average yield was 5.4 DMtons/A (Appendix 1). However, in 1991 kenaf yields were somewhat lower. Averaged across four locations, the average yield for Tainung #1 was 4.4 DMtons/A and for C-108 was 4.0 DMtons/A (Table D-19). We believe this trial should be repeated in 1992.

In addition to field testing, we explored the possibility of using natural fibers to substitute for petroleum based materials in the manufacturing of plastic products. To test the feasibility of injection molding kenaf fiber, a trial run using wood fiber was injected molded into small office supplies at the then W.T. Rogers Corporation. Except for a bad smell, the results showed it may be feasible to injection mold kenaf, provided the properties are similar to wood.

Finally, in 1991, a proposal was written to the UW Center for Integrated Agricultural Systems to examine the feasibility and desirability of developing new kenaf agricultural/industrial processes in Wisconsin. This proposal was selected for funding as a team building project over the period of July 1, 1991 through June 30, 1992. The team would consist of an interdisciplinary team of both farmers and researchers from the UW campuses at Madison, Platteville, Stevens Point and at the U.S. Forest Products Laboratory.

AGRECOL CORPORATION is very thankful to the Wisconsin Department of Agriculture, Trade and Consumer Protection for the opportunity to explore the potential of a new crop for Wisconsin agriculture.



1990 KENAF VARIETY OBSERVATION PLOTS - AGRECOL RESEARCH STATION, MADISON, WI

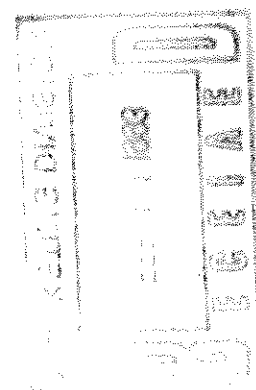
Planted June 5, 1990 - 6 rows/plot @30", 30' long, 5 seeds/foot, approximately 90,000 seeds/acre. Resulting stands very uneven due to germination problems. Weeded mechanically and manually. No fertilizer - previously low maintenance, unfertilized lawn. Flower initiation during 2nd week in September. Killing frost on October 10, 1990.

DESCRIPTION	GENERAL PLOT CONDITIONS/ CHARACTERISTICS	LEAF TYPE	STALK	DISEASES	NET WEIGHT 10/15/90	AIR DRIED WEIGHT 11/20/90	PLOT WEIGHT 100% DM	DM #/ACRE	DM TON/ACRE
EVERGLADES 41	Shorter variety, good stand, 3-5 plants per ft. (50,000-90,000 per acre.) Many plants dwarfed where stand is denser than 4/ft.	very shallow lobed	average height is 8'.	none apparent	49.5 #	23 #	13.3 #	11,584	5.8
GUATEMALA 4	Shorter variety, mediocre stand, (approx. 50,000/ac.) Some lateral branching.	very shallow lobed	average height is 8'	1/2% stalk rot. Mainly mid-stalk lesions.	40.0 #	19 #	11.0 #	9,581	4.8
CUBA 108	Best plot, visually - good germ, good stand. (approx. 70,000 plants/acre) little lateral branching. Optimum apparent plant density - where denser many plants dwarfed.	very shallow lobed	04/row ft., 9'3" tall & 2 1/2-3" circum. @2" above grade. @6/ft., 8'0" and many dwarfed.	1% stalk rot. Mainly mid-stalk lesions.	48.5 #	23.1 #	13.4 #	11,671	5.8
CUBA 2032	Poor stand (approx. 26,000 plants/acre), resulted in more lateral branching & reduced height. Similar to C108. Appears less productive, but worth re-evaluation at higher plant density.	very shallow lobed	average ht. 8 1/2'	2% stalk rot	33.5 #	17 #	9.9 #	8,623	4.3
TAINUNG #1	Poor stand, germination problem. (approx. 26,000 plants/acre). Tremendous lateral branching, some laterals over 6 ft. long, with much consequential lodging.	very deeply lobed	Tallest plants 11'2". At 4/row ft., ht. reduced to 9'4".	1% stalk rot	52.1 #	23.5 #	13.6 #	11,846	5.9
TAINUNG #2	Very poor stand, germination problems (approx. 17,000 plants/acre). Tremendous lateral branching, many lodged. Some open-grown plants with basal stalk circumference over 7"	very deeply lobed	Tallest = 12'3" Average = 9'8" No area w/good population	2% stalk rot	49.5 #	23.1 #	13.4 #	11,671	5.8

1990 KENAF VARIETY OBSERVATION PLOTS - AGRECOL RESEARCH STATION, MADISON, WI

Table D-19. Kenaf Variety Trial at Four Locations
Expt. 9128

Location	Variety	Planted	Harvested	DM Yield lb/a	Harvest Moisture %	Plant Height in.	Harvest Population ppa	Lodging %
Arlington		May 22	Oct. 15					
Lancaster		May 21	Sept. 30					
Marshfield		June 12	Oct. 1					
Spooner		May 17	Sept. 25					
Arlington	Tainung #1			8097	70.4	70	87990	
Arlington	C-108			8291	69.3	77	93220	
Lancaster	Tainung #1			9440	76.2	101	105415	3
Lancaster	C-108			9720	78.3	95	81022	0
Marshfield	Tainung #1			9409		72	74925	
Marshfield	C-108			7318		72	66200	
Spooner	Tainung #1			8465	88.0	96	42399	
Spooner	C-108			6515	82.1	80	26137	
Ave.	Tainung #1			8853	58.7	85	77682	3
Ave.	C-108			7961	57.4	81	66645	0



DEVELOPMENT AND COMMERCIALIZATION OF KENAF: NEWSPRINT LEADS THE WAY

Daniel E. Kugler

Asst. Deputy Administrator, Special Projects and Program Systems
U.S. Department of Agriculture-Cooperative State Research Service

Kenaf is an annual, nonwoody fiber plant native to east-central Africa. It is an herbaceous plant closely related to cotton and hollyhock, and is a member of the Malvaceae family. Kenaf may have been domesticated as early as 4000 BC, with the leaves used for food and the bark for weaving and rope making.

The kenaf plant stalk consists of an outer bark or bast fiber and an inner core fiber. The bast fibers, roughly 30 percent of the stalk, are about 2.5 mm in length. The shorter core fibers are about 0.6 mm in length and constitute the remaining 70 percent of the stalk.

Kenaf is planted in rows, using standard farm equipment. It reaches heights of 12 to 18 feet and, depending on conditions and variety, yields 6 to 10 tons of dry fiber per acre. The plant requires a soil temperature of 55 degrees for germination, and needs a 100-150 day growing season to reach maturity. Most kenaf varieties are photoperiod sensitive, changing from vegetative to reproductive growth at around 12.5 hours day length.

Research and Development from the 1940's to 1978: An Era of Public Leadership

In the United States, agricultural research began in the 1940's as the U.S. Department of Agriculture began to explore kenaf as a substitute for jute in the manufacture of cordage products such as string, rope, and bags. Work in this era was spawned by experiences in Asia and Africa where kenaf was actively utilized to replace or blend with jute.

The agricultural research program was comprehensive. It covered plant adaptation, climatic adaptation, soils, cultural practices, breeding and selection, rotations, and many other facets of kenaf seed and fiber production. These programs remained largely intact through the 1970's.

The original research was directed at substitution for jute and included work to achieve mechanical ribboning to separate the bast fiber from the core. This first stage material processing was designed to prepare the bast fiber for retting and introduction to the jute-using market. Efforts were abandoned in the late 1950's as they proved to be unprofitable, due principally to high labor requirements and environmental problems.

In the late 1950's, the USDA-Agricultural Research Service (Northern Regional Research Center, Peoria, Illinois) initiated a project to screen more than 500 mostly nonwoody plants for their potential in pulping and papermaking. The effort culminated in 1960 and kenaf was identified as the most promising plant. This triggered continuation and resurgence of agricultural research programs for kenaf. It also triggered the beginning of 18 years public leadership in research and applied research in a new and different product area for the kenaf crop.

Work at the Northern Regional Research Center focused on basic chemical and physical properties and explored the use of wholestalk, core, and bast fibers in a variety of

uses. Stamps, currency, raw stock coating, bond paper, newsprint, carpet pads and many other product uses were studied.

The use which generated the most interest was newsprint. Newsprint manufactured from wholestalk kenaf showed very desirable pulping qualities and characteristics. The thermomechanical pulping process consumed considerably less energy than wood, required less chemical use to brighten to newsprint grade, and maintained or exceeded wet-web and dry-end strength properties necessary for high speed, continuous newsprint manufacturing.

Newsprint also captured the attention of newspaper publishers, the American Newspaper Publishers Association in particular. Printing and pressroom tests showed kenaf newsprint to be bright with excellent ink lay-down, a highly desirable quality for the advertisers and readers who pay the cost for newspaper publishing. The kenaf newsprint had strength characteristics to run on high speed commercial presses and consumed less ink with reduced ink rub-off.

The Agricultural Research Service led the first applied research efforts for kenaf newsprint with cooperation from private industry. As a result of the Department of Agriculture program and participation of International Paper, kenaf newsprint was manufactured and used to print a limited edition of the Peoria Journal Star (Peoria, Illinois) on August 8, 1977. It showed, under far less than ideal conditions, that kenaf newsprint manufacture and use was technically feasible. At this time, the Agriculture Research Service believed that kenaf, and kenaf newsprint in particular, had reached a point of adequate scientific visibility and acceptance. The Agriculture Research Service left its kenaf program in 1978 in hopes that private industry would continue efforts to commercialize kenaf.

Development from 1979 to 1985: A Period of Private Leadership

From 1979 to 1985, kenaf indeed went into a period of private leadership. In this period, several important advances for kenaf newsprint were made. In 1979, the American Newspaper Publishers Association and International Paper conducted a newsprint manufacturing run at Pine Bluff, Arkansas and sent the newsprint to six newspapers for pressroom runs. Again, the effort was technically successful and served to stimulate continued product development.

In 1981, another commercial scale newsprint manufacturing run was conducted at International Paper's Mobile, Alabama mill. It was the first time that kenaf handling, pulping and newsprint manufacture took place at one location in continuous steps. It set the stage for considering full scale mill operation with kenaf. Each kenaf newsprint manufacturing and pressroom run had built upon previous experiences, correcting problems and adding enhancements. The results from each of the 1977, 1979, and 1981 runs were considered individually successful. Together, the three runs were very progressive and sufficiently encouraging for the American Newspaper Publishers Association to sponsor a general feasibility study for a kenaf newsprint system. The 1982 report thoroughly examined all needs for commercial adoption of kenaf. It included agriculture (seed and fiber production, harvest, handling, storage), pulping (raw material handling, refining, quality), papermaking (runability, quality, markets) and publishing (pressroom runability, printability, acceptability).

While the Kenaf Newsprint System report was being prepared, a small, joint venture company, Kenaf International, was formed in California solely to commercialize kenaf. During the next 4 years (1981-1985), Kenaf International successfully worked to develop a commercial scale seed supply, improve farm production methods for the fiber and generate

interest within the pulp and paper industry to use kenaf as a supplemental fiber with wood in newsprint manufacture.

In 1985, the U.S. Department of Agriculture and Kenaf International reviewed progress made for kenaf newsprint during the public leadership era ending in 1978 and the then-current era of private leadership. It was concluded that great strides toward commercialization had been made in agriculture and in the pulp and paper industry during the private leadership era. It was also concluded that solving or removing some of the remaining barriers to commercialization would be a formidable task.

It was known that a larger, even more successful, commercial scale mill and pressroom run would be needed to satisfy the paper industry's needs for data and hands-on experience. It was known that agriculture needed to build and test farm equipment for fiber harvest and handling. It was also known that bringing two traditional industries (row crop agriculture and pulp/paper) together over a new fiber crop would be a major institutional hurdle.

Under authority of the Food Security Act of 1985, the U.S. Department of Agriculture and Kenaf International outlined a public/private partnership to jointly work on remaining commercialization barriers. This partnership marked the beginning of an era of joint public/private leadership which would involve Federal and State agencies, several universities and a number of prominent, private companies.

Development and Commercialization from 1986 to 1988: Years of Joint Public/Private Leadership

Early in 1986, USDA and Kenaf International initiated the Kenaf Demonstration Project, a public/private effort to promote acceptance of kenaf fiber in manufacture of pulp and paper products. This project identified several barriers to commercialization and planned a multi-phase project to remove those barriers. Major accomplishments under the Kenaf Demonstration Project have been:

- (1) successful refinements in the pulping process (1986-1987)
- (2) successful newsprint manufacturing tests using kenaf pulp on a high speed, twin-wire research machine and comparison to southern and northern furnishes as controls (1987)
- (3) successful commercial scale pulping, newsprint manufacture and pressroom run (1987)
- (4) successful development and testing of a kenaf harvest system including harvester, grab-loader, hauling wagons and storage yard stacker (1987-1988)
- (5) re-start of USDA agricultural research, extension and education programs at Agricultural Research Service field stations and land grant universities (1988-1989).

The Kenaf Demonstration Project currently awaits private business plans to build a \$400 million newsprint mill in South Texas for operation in the early 1990's. Even so, the project moves ahead during 1988-1989 to conduct a cooperative project to refine and demonstrate a technology for fiber separation and use the core and bast fibers for specification testing and chemical and physical properties research for many other products. Potential products include poultry litter, dry-formed fruit boxes and interior parts for automobiles, composting of municipal sludge, carpet padding, cellophane, roofing felt, and

other uses. In addition, direct and related work is underway to blend kenaf thermomechanical pulp with southern pine pulp and with deinked (recycled newsprint) pulp for newsprint furnishes.

The public/private partnership has involved many individuals and their institutions. Principal cooperating private organizations include Kenaf International, Canadian Pacific Forest Products, C-E Sprout-Bauer, Beloit Corporation, Rio Farms Inc., H. Willett and Company, and Lummus Development Corporation. The U.S. Department of Agriculture's Agricultural Research Service is the major public sector cooperator for support, data and information, and expert assistance. The U.S. Department of Agriculture's Cooperative State Research Service has been responsible for planning, development, leadership and accountability of the Kenaf Demonstration Project.

Kenaf Comes of Age: 1989 and Beyond

The research and development work which is in place now and the work now evolving is maturing toward separate yet interactive roles for the public and private sectors. We each are headed to the work arena we do best in and look to each other for guidance and support in preparing a research and development agenda which is mutually beneficial.

For Federal and State government and universities, we are challenged by the new role we are about to assume with kenaf. Our job is to develop the agricultural education, research, and extension systems so that farmers can become reliable suppliers of the raw material kenaf fibers to industry and to lead research into new areas of fiber use. This is a very broad role which is just now beginning to be realized.

For industry, the challenge comes in the form of forging ahead with new businesses based on a new raw material with new raw material suppliers. The risks and payoffs of such innovation can be high. However, many years of research and development are now an opportunity for growth and adoption of technologies for kenaf newsprint and other marketable products. The private sector must carry the opportunity to the market place and sustain it. This is also a very broad role just now being realized.

If agriculture and industry can accept and meet these challenges, we can begin to satisfy or alleviate the Catch-22 problem which often confronts new/alternative crop and product development. This Catch-22 often finds agriculture unwilling to invest necessary resources to establish cost-effective farm production of the raw material until industry shows a willingness to purchase the raw material. It finds industry unwilling to invest in product and market development until agriculture can prove it can reliably deliver raw material at an acceptable price. All too often, the result is that neither agriculture nor industry do anything, or, at best, piecemeal work is done by a loosely associated group of individuals. Frequently in agriculture, government and university people will take promising plants "underground." That is, they'll bootleg new crop research on other projects or simply work at them as a hobby in order to preserve some semblance of continuity.

Summary

There are many forces behind kenaf arriving at the brink of commercialization. The dominant forces are market relevance, public leadership and private leadership:

(1) Market Relevance

- + drove the introduction in the 1940s as a jute substitute
- + drove the work beginning in 1960 for pulping and papermaking

- + singled out newsprint during 1970s as demand-pull, quality product
- + will drive other products such as carpet felt pads

(2) Public Leadership

- + necessary to initiate and sustain research and development for basic properties and characteristics
- + established cadre of cooperators - public, university and private scientists
- + has the research, education and extension role in the agricultural infrastructure
- + provides assistance in overcoming/understanding institutional and regulatory barriers

(3) Private Leadership

- + necessary to take research and development to the market place, including internalization of testing and scale-up work
- + necessary for the assumption of financial and business risks and returns
- + actively participates with public sector to help shape research and development programs for emerging technologies and needs
- + will produce a crop/product "champion" to lead commercialization work

The development and commercialization of kenaf, with newsprint leading the way, has taken a long time and still waits for a business to be founded. It is natural to ask "In hindsight, what could have been done differently to accelerate or speed-up the commercialization process?"

Market relevance has been in place with newsprint since the mid-1970s. Private participation and leadership has been in place since the mid-1970s. Public leadership was in place from the 1940s through 1978 and again beginning in 1986 with research programs re-starting in 1988. The eight year gap in public leadership and the ten year gap in public agricultural research must be looked at critically. The lesson applies to kenaf specifically and to new industrial crop commercialization in general.

It is the responsibility of the public sector be the backdrop for sustaining research and development for new, alternative crops and their products. New crop development is a long-term program, usually much longer than private industry's business planning timeframe. At some undefinable point in the research process, a technology may become ready for transfer to the private sector for commercialization. In 1978, the technology for manufacturing newsprint from kenaf fibers seemed ready for transfer. Subsequent work in the private sector seems to verify this notion.

However, one wonders why the U.S. Department of Agriculture agricultural research program for kenaf was terminated. Surely it was realized at the time that successful technology transfer would lead to expanding acreage of a new plant for agriculture and related research needs. This in turn requires a sustaining program of agricultural research, education and extension.

In hindsight, a small agricultural research program for kenaf should have been maintained when the product development work was terminated in 1978. Even a small program over ten years could have made significant progress in such areas as cultural practices, breeding and genetics, and germplasm. A small active program could have been helpful in providing information to assist in the private development of a commercial agricultural business.

The lesson to be learned from the kenaf experience is quite simple. The U.S.

Department of Agriculture's agricultural research mission must continue uninterrupted, even after technology transfer for raw material processing, product development and manufacture begin or are anticipated to begin by private industry. Anything less sends a counterproductive message to industry.

SELECTED REFERENCES

1. Dempsey, J.M. Fiber Crops. Gainesville, Florida: The University Presses of Florida, 1975.
2. International Kenaf Conference. Transcription of presentations at event sponsored by the American Newspaper Publishers Association, San Francisco, California: April 29, 1982.
3. Kugler, D.E. "Kenaf Newsprint: Realizing Commercialization of a New Crop After Four Decades of Research and Development." Washington, D.C.: U.S. Department of Agriculture - Cooperative State Research Service, June 1988.
4. Soil and Land Use Technology, Inc. General Feasibility Study: Kenaf Newsprint System. Reston, Virginia: American Newspaper Publishers Association, March 1982.
5. Technical Association of the Pulp and Paper Industry (TAPPI). "A Search for New Fiber Crops." A series of 16 research reports published from 1960-1971 by TAPPI from works principally by scientists of the U.S. Department of Agriculture, Agricultural Research Service, Northern Regional Research Center, Peoria, Illinois.

